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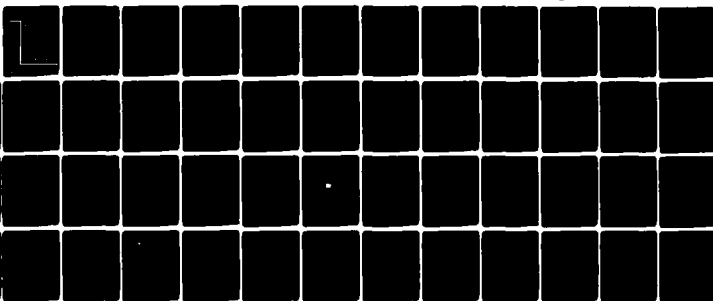
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6883 MAINTENANCE TRAINING SIMULATOR DEVELOPMENT  
UTILIZING IMAGERY TECHNIQUES

By

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Final Report

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This final report was submitted by BioTechnology, Inc., 3027 Rosemary Lane, Falls Church, Virginia 22042, under Contract F33615-78-C-0047, Project 2361, with the Technical Training Division, Air Force Human Resources Laboratory (AFSC), Lowry Air Force Base, Colorado 80230. Mr. Gary G. Miller was the Contract Monitor for the Laboratory.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

MARTY R. Rockway, Technical Director  
Technical Training Division

RONALD W. TERRY, Colonel, USAF  
Commander

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imagery	procedural learning	technical training													
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  <p>This exploratory study evaluated a low fidelity, imagery-based simulation technique to determine its effectiveness in training certain avionics maintenance tasks. The technique was compared experimentally with conventional (technical order) training materials in terms of its ability to produce learning of procedural tasks. On learning tests, groups using the imagery training materials (experimental) scored significantly better than groups using the conventional materials (control) on one out of four tasks. The control groups likewise significantly outscored the experimental groups on one out of four tasks. On a delayed retention test, the scores of the experimental groups declined more than did those of the control groups (who displayed no significant loss of learning). Further tests are recommended to (a) determine optimum difficulty level for</p>															

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application of the technique, (b) isolate the technique's elements and evaluate them individually, and (c) investigate the individual effect on training of various components of the imagery training materials.

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## SUMMARY

The purpose of this exploratory evaluation was to evaluate the effectiveness of a low-cost, low fidelity simulation technique in an Air Force maintenance training environment. The technique relies on the generation of mental imagery to promote learning primarily through spatial, rather than verbal, orientation. This report presents the results of an experimental comparison of the imagery technique with a control method (based on the conventional maintenance technical orders). Air Force technical training students were trained using both methods and subsequently tested for retention of learning.

The experimental environment was that associated with the 6883 Test Station used for maintenance of avionics components of the F-111D fighter aircraft. Four preliminary turn-on and set-up tasks on this equipment were selected for training and testing. Prepared experimental materials consisted of printed study guides, a photographic scale model of the 6883 Test Station, and for the experimental group, special aids for the manual practice of task steps. The control group's study booklet was completely verbal and simply reprinted the appropriate parts of the technical orders. The study guide for the experimental group broke the same technical order instructions into discrete steps and presented them graphically as well as verbally, keyed to line drawings of the appropriate panel(s) on the 6883.

The test results were mixed as to the superiority of the imagery technique in promoting learning and transfer of training. Students trained using the imagery technique scored significantly higher than did controls on task 1, which was rather long and difficult. However, controls scored significantly higher than the imagery group on task 3, which was much shorter and apparently easier to verbally memorize. There was no significant difference between groups on the delayed recall test. One explanation for these findings is that the imagery technique might be most effective on more difficult tasks; since there was evidence that the tasks selected were relatively easy to perform, a "ceiling" effect may have minimized the performance differential between the two techniques. Another leveling effect may have derived from the use by both groups of the photographic mock-up of the test station. Observation during the experiment suggested that the model was actually being used by the control group in such a way as to inject an element of imagery into their training as well.

Further study of this technique is recommended, as follows:

- a) Investigate its use in tasks with higher spatial demands.
- b) Determine the optimum difficulty level for its use.
- c) Determine the optimum distribution of practice.
- d) Isolate its elements for evaluation individually.
- e) Investigate the effectiveness of the photographic model alone as a training aid.



## PREFACE

This research was sponsored by the Technical Training Division, Air Force Human Resources Laboratory (AFSC) under Project 2361, Contract No. F33615-78-C-0047. Mr. Gary G. Miller was the contract technical monitor.

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## INTRODUCTION

The work described in this report is part of a larger advanced development effort, Air Force Project 2361, which involves the design, development, test, and evaluation of a wide variety of maintenance simulation techniques for Air Force technical training. Project 2361 was initiated in response to the growing costs of actual equipment used for maintenance training, and the unsuitability of this equipment for training in many cases. A primary goal of Project 2361 is to enable Air Force personnel involved in the design and procurement of maintenance training devices to select the most cost- and training-effective applications available. To this end, the project is developing and evaluating a wide range of simulation techniques and preparing guidelines for their use, based upon systematic, empirical investigations. The range of technology demonstrated in Project 2361 extends from low fidelity paper-and-pencil approaches, through two-dimensional panel representations, to more elaborate three-dimensional replicas of actual equipment.

While several previous efforts under Project 2361 (McGuirk, Pieper, & Miller, 1975; Miller & Gardner, 1975) have concentrated on relatively high fidelity approaches, the purpose of this study was to investigate applications of low-cost, low fidelity techniques to Air Force maintenance training. The concept of fidelity, as applied to training devices, is used here in the sense that was discussed by R.B. Miller (1954). He classified fidelity of simulation as belonging to two overlapping categories: engineering fidelity and psychological fidelity. The basic distinction between the two categories is that high fidelity often corresponds to an emphasis on engineering hardware duplication, while the use of low physical fidelity approaches implies that transfer of training, or psychological fidelity, is the more relevant consideration. This concept is important, since transfer can theoretically be achieved by any means that result in the student's perception that the training environment realistically simulates the "real world" job environment. A corollary of the argument for low fidelity has been that departures from strict engineering realism, when based on a well-thought-out analysis of training requirements, can result in better transfer of training than more elaborate, high fidelity approaches that do not consider the importance of instructional features. Miller (1954) states that, "At least from the standpoint of economy, the development of training devices should rest on psychological simulation rather than engineering simulation. Therefore,

to the extent that engineering simulation is a matter of selection and of degree, the selection of variables should be based on psychological considerations as to what will maximize validity of training." There have been demonstrations (Grimsley, 1969; Miller, 1974) that a low fidelity training medium is capable of producing equal or better learning, especially for procedural tasks, than are higher fidelity media. Investigations of low fidelity techniques are important, then, for several reasons: (a) the inherent low cost of such techniques, (b) the accumulated evidence that transfer of training will not suffer for certain procedural tasks, and (c) a potential improvement in the efficiency of training equipment utilization rates through the employment of inexpensive low fidelity approaches.

Many of the low fidelity approaches can also be considered as symbolic substitutions for real equipment. In these, a photograph, line drawing, or other abstract representation may be used in place of the actual equipment. Symbolic methods often rest on the premise that a student's mental processing of symbolic materials can produce cognitive representations of job task structures that are functionally similar to the cognitive representations formed in operating the real equipment.

#### Forming Cognitive Representations of Training Tasks

The idea that a symbolic representation of a job task or equipment configuration can be an effective training medium when compared to practice on real equipment is certainly not new. Miller's (1954) concept of psychological fidelity is strongly tied to the notion that the student's internal representation of the job task is a highly important factor in transfer of training. Theoretically, if students perceive a low fidelity environment to be realistic (in the sense that training system stimuli and responses are seen as equivalent to those of a "real" system), then their internal representations of the job task should be equivalent to the internal representation formed in a training environment that has high engineering fidelity. This is especially true if the task is procedural in nature. An important factor here is that practice of a procedure that has a low psychomotor component can be thought of as essentially a mental task anyway; therefore, level of engineering fidelity need not be an overriding consideration in the design of a learning environment for procedural tasks, especially those that have low psychomotor requirements.

A similar but more elaborate form of the perceptual equivalence idea was developed by Sheffield (1961). He observed that the nature of some tasks is such that a student may learn a sequential procedural task without any overt performance, simply because a single demonstration may be sufficient to provide the perceptual and symbolic representations necessary for learning. More complex procedural tasks which require practice to learn, however, result in the formation of perceptual "blueprints." The student refers to this internalized blueprint in performing a sequential task. Sheffield suggests that "the mechanics are the same whether the person matches his behavior to an external blueprint or . . . to a memory image. The memory image is like a 'blueprint,' and the learner continues to manipulate it until his perception of his immediate product matches his perceptual memory." In line with Sheffield's theoretical considerations, there have been recent suggestions that imagery, which is functionally equivalent to Sheffield's "blueprinting," can play a major role in the learning of complex, sequential subject matter.

While a great deal of controversy exists about the definition of mental imagery, this study will focus on visual imagery as defined by Paivio (1971). He defines imagery as nonverbal representations of concrete objects or events, or nonverbal modes of thought in which such representations are generated and manipulated by the individual.

#### Imagery as a Training Technique

Interest in the potential of imagery as a learning strategy has gained momentum in the past few years, partly as a result of the growth and influence of cognitive psychology. A substantial body of literature has accumulated that shows imagery to be a powerful strategy for learning verbal materials (Paivio, 1971). Most of this research has been concerned with the effects of imagery on the learning of verbal paired-associate tasks and, to some extent, narrative verbal materials. However, very little is known about the application of imagery strategies to complex sequential-learning tasks or nonverbal tasks, which are typical of those to be learned in the operation and maintenance of military systems. One general finding has been that imagery strategies are most effective when interacting images are formed for concrete verbal materials (Bower, 1972).

To explain various effects of imagery, Paivio developed a dual-code theory, involving separate but interacting verbal and visual systems, which proposes that materials high in imagery value (high image-evoking capability) are learned better when they are encoded into memory by the student, both visually and verbally. Thus, imagery can provide an additional way of knowing a fact or a concept, thereby affording a dual opportunity for learning and remembering. Rigney (1974) takes a somewhat different approach to the use of imagery by concentrating on the nonverbal processing functions assumed to be localized in the right hemisphere of the human brain.

Since much of the material that is learned in a military maintenance environment consists of complex verbal, procedural chains integrated with equipment functions, there is little opportunity for the formation of interacting visual images. Typical procedural tasks are long and somewhat abstract with respect to image-evoking capability; consequently, there is little reason to believe that imagery strategies would be effective for acquisition and recall of such procedures, even if this capability were desired. Indeed, Paivio (1971) states that imagery does not lend itself to the processing of sequential materials unless it is linked to a motor response system. Rigney, on the other hand, has concentrated on stimulating imagery processing of materials through graphic displays. His assumption is that imagery processing stimulated by graphic presentations *along with* verbal processing requires the learner to process the material more completely, which results in better learning and retention. Thus, the use of imagery in this sense refers to a higher level of imagery processing involving visual analogies, as opposed to a more micro-level image generation for word pairs. According to Rigney (1974), visual analogies can be used the way verbal analogies are used, i.e., "to illustrate processes in more familiar, albeit highly simplified terms."

A similar argument has been presented by Gagne (1978). He suggests that intellectual skills such as procedure-following can be more effectively learned when instruction specifically links images with the appropriate intellectual skill. However, Gagne notes that few investigations have attempted to test the effects of combining verbal and imagery strategies on the retention and transfer of intellectual skills (such as procedure-following).

### Recent Studies Using Imagery for Technical Skills

Two recent studies have applied components of the theoretical models just described to the learning of procedurally oriented tasks. One is a study utilizing the mental practice concept with Air Force student pilots (Prather, 1973); the other involves the learning of assembly-line tasks in an industrial setting (Johnson, 1978).

Prather defines mental practice as an attempt to imagine vividly the perceptual motor actions involved in practicing a skill. Students using mental practice were prompted by tape recordings describing landings of the T-3 aircraft. Promptings were then gradually faded to encourage mental imagery. Prather found that mental practice combined with actual practice was more effective than actual practice alone. Furthermore, following an actual flight performance, both procedures were improved via use of mental practice. While Prather's study was concerned with the flying training environment, it is quite likely that the mental practice phenomenon could be applied to maintenance training as well.

Johnson (1978) investigated the use of three different strategies varying in imagery utilization for learning a procedural task that involved the setup of a conveyor-line production operation. Control of imagery demand was determined by reductions in the stimuli that provided visual cueing and feedback. The results indicated that (a) training devices do not need high fidelity to be effective in training procedural tasks, and (b) training strategies that require trainees to provide their own cueing and feedback from memory are effective in increasing the retention of procedure-following skills.

### Purpose of the Study

The purpose of the present exploratory study was to evaluate the feasibility and training effectiveness of an imagery technique in training tasks involving maintenance of avionics components from the F-111D. Due to the apparent potential for imagery-based strategies in both mental practice and procedural tasks, a need exists to develop techniques for applying imagery to a variety of training environments. One promising technique that has been developed was used to guide development of the

experimental materials. While this technique was developed primarily for training commercial pilots, the generality of the process appeared to lend itself quite well to an Air Force maintenance training environment. The technique purports to use visual imagery to enhance learning and has been described as a novel method and means for determining the extent or accuracy of an individual's complete mental picture of some previously memorized graphical matter. To use the technique, the subject graphically reproduces portions of the previously memorized matter, e.g., a geometric figure; but the subject's reproduction is hidden from view, thereby preventing visual feedback in the ordinary sense. Thus, the subject is forced to rely solely on a mental picture when reproducing the object. Feedback can then be provided so that the subject may judge the accuracy of the reproduction. This is done by having the subject lift a cover sheet on the imagery material to reveal how the reproduction matches the standard. One objective of the technique is to provide a means for graphically recording students' responses while stimulating and developing their ability to mentally visualize and recall previously presented material.

The major question posed in this research was whether the imagery technique produces procedural task learning (as measured by delayed recall) that is equal to or superior to a control method that would appear to lack some of the imagery-evoking features of the imagery technique. An additional purpose of this exploratory analysis was to identify the need for future research involving imagery techniques in technical training applications.



## METHOD

The experimental environment for the imagery evaluation was that associated with the 6883 Test Station. This automatic test equipment is used to perform checkout of F-111D converter and flight controls at the intermediate level of maintenance. Four tasks were selected that were representative of those performed on the 6883 Test Station. Imagery training materials were developed to teach these four tasks and evaluated against conventional training materials.

### Subjects

Air Force students in training at Lowry AFB, Colorado, were used as experimental and control subjects. They participated in the experiment while awaiting their next block of technical training. All subjects were familiar with electronic equipment but naive regarding the 6883 Test Station.

Subjects were processed in groups of seven, with all subjects in a group participating in the same treatment condition. Subjects were assigned to groups based on their availability from their squadron at the particular time period of the test session. Groups were varied between experimental and control conditions until all required data were collected. A total of 53 subjects participated over a 5-day period, with 26 subjects in the experimental group and 27 subjects in the control group.

The experimental group used the imagery training materials and the control group used the conventional training materials.

### Materials

The imagery training materials consisted of a study guide (Appendix A, Exhibit A-1) and a practice environment.

The purpose of the study guide was to transition the user from the verbal steps of a task to the actual imagery-producing practice. The study guide had two principal features. First, it provided a verbal step-by-step description of the tasks; this included the exact information given in the technical orders, followed by a breakdown of this information into individual steps. The study guide next showed both the physical mark the user was to make on

the environment when practicing the tasks and where the correct mark should be made for each step. This mark was symbolic of the actual manipulation or observation that a technician would make on the equipment when doing the task.

The practice environment consisted of a two-by-three-foot board used to mount photographs of the 6883 Test Station panels in the same orientation as those of the actual equipment. Line drawings of the Test Station sections (Appendix A, Figure A-2(a)), with appropriate answer keys (Appendix A, Figure A-2(b)) could be clipped over the corresponding photographs to allow for task practice. A user's practice marks were made with a plastic stylus and were recorded on a "magic slate" underneath the line drawing and answer key. The answer keys were produced of colored acetate with a task's correct marks appearing etched in clear acetate. This allowed the user to see both his own marks and the correct ones for comparison.

The conventional training materials were similar to the information available in the technical orders (T.O.s). The written instructions in the T.O. for each task were reprinted in a small booklet (Appendix A, Figure A-3). This material was the same as that found in the first column of the experimental group's study guide. Also, the T.O. section entitled Operating Controls and Indicators was duplicated and provided to each control-group subject. The pictures in this section aided the user in locating particular parts of the test station equipment. Finally, the control group was provided with the photographic mock-up of the 6883 Test Station (including only the photographs, not the experimental materials).

### Procedure

Introduction. All subjects in each group were first given a brief introduction to the experiment (Appendix B.I). They were told to evaluate some training materials, but were not told anything about the different groups in the experiment.

All subjects were then given a memory test for geometric shapes. They were asked to study 15 different designs printed on a piece of paper (Appendix B.II). After 5 minutes of study, the subjects were given a blank piece of paper and asked to draw as many designs as they could remember without the help of the study sheet. The

15 designs varied from regular and simple to irregular and complex. Their scores on this test were used as a measure of imaging ability.

The training materials to be used by the particular group were described to the subjects. This description included instructions on how to use the materials to study a task.

The control group's introduction was relatively brief and straightforward, since the subjects were familiar with this type of material. Only the photographic mock-up was unfamiliar. Control subjects were told to study the tasks as they would normally study similar material. They were to read through the T.O. steps and use the mock-up as a reference to the real equipment. Practice was to be accomplished by mentally reviewing the task steps.

The experimental group's introduction was longer than that of the control group, since subjects were completely unfamiliar with the imagery training materials. The purpose of both the study guide and the practice environment was explained and the mechanics of their use demonstrated. To use the materials, subjects were instructed to first review the study guide to familiarize themselves with the task's steps. Then they were to try making the marks on the practice environment while following along in the study guide. Gradually, they were to shift entirely to the practice environment and refer to the study guide only if necessary.

Training. The training sequence was similar for both experimental and control groups. All subjects were familiarized with a task by having the task's description and purpose read to them. After reviewing the appropriate materials, they were given time to study the task steps. Study time varied from 10 to 20 minutes per task, depending on the task complexity. Both groups were given the same amount of time for each task, and all subjects were told before they began that they would be asked to write down the task sequence from memory.

Immediately following the study period, a learning test was administered. The training/test sequence was repeated for all four tasks. The order of presentation and study of tasks was:

1. Preliminary control settings
2. Turn-on procedure
3. Setup for adjustment of power supply A2A9PS4
4. Calibration of the AC voltmeter on the variable power control.

All subjects were given a 10-minute break between tasks 2 and 3.

Testing. Immediately after studying each task, subjects were tested. Each subject was given an answer sheet and the photographic mock-up of the test station. Using the mock-up, the subjects were asked to imagine themselves actually performing the task and then to write down the procedural sequence of the task in as much detail as possible. Although accuracy was stressed, it was emphasized that any partial information was acceptable.

After they had finished the fourth training/testing sequence, the subjects were given a retention test for the first task (Preliminary Control Settings). The testing procedure was similar to the one used previously. Subjects were not told beforehand that a test was to be given. Approximately 2 hours had elapsed since subjects had studied the first task.

After the retention test, all subjects were asked to fill out an attitude questionnaire (Appendix B, Figure A-3). Finally, subjects were debriefed on the nature of the experiment.

Scoring. Test answers were scored with a predetermined answer key. Each task step was divided into substeps, and a point was given for accuracy on each substep. For example, setting a RANGE control to "100" involved the substeps of (a) correct control, (b) correct setting, and (c) correct sequential order. Each subject was assigned a score based on the percentage correct.

## RESULTS

On the imagery pretest, the experimental group achieved a mean 55% accuracy in reproducing the geometric figures. The control group scored a mean 60%. This difference was not statistically significant; therefore, there appeared to be no difference in imaging ability between the two groups as operationally defined by the imagery pretest.

Table 1 shows the mean percentage correct for groups on the learning and retention tests of task 1. These data were analyzed by a 2 x 2 repeated measures analysis of variance (ANOVA). ANOVA was used in this context to determine if there were significant differences between the experimental and control groups. ANOVA also permits an assessment of interaction and main effects and can indicate whether significant differences were consistent or varied across groups. The factors were experimental versus control group and immediate recall versus retention test. The interaction of groups x test was significant ( $F(1,51) = 14.61, p < .01$ ). The experimental group scored significantly higher on the learning test but no differences were found on the delayed recall test. The main effect for tests ( $F(1,51) = 22.78, p < .01$ ) was also significant, indicating that there was a significant difference between the immediate and delayed recall tests. The main effect for groups was not significant, indicating no significant differences between groups over the two tests. The analysis of variance summary table is shown in Appendix B, Table B-1.

Table 1

Mean Percentage Correct for Groups on the  
Learning and Retention Tests of Task 1

Group	Test			
	Learning		Retention	
	$\bar{x}$	s	$\bar{x}$	s
Experimental (N=26)	64.8	11.2	51.7	14.8
Control (N=27)	52.6	21.0	51.0	18.5

Table 2 shows the mean percentage correct for groups on the learning tests of tasks 2 to 4. These data were analyzed separately for each task by a  $t$ -test between the experimental and control groups. As can be seen in Table 2, the differences between the experimental and control groups were not significant on tasks 2 and 4. The difference on task 3 was significant, with the control group scoring higher than the experimental group ( $t(51) = -3.49$ ,  $p < .002$ ).

Table 2

Mean Percentage Correct for Groups and  
 $t$ -scores on the Learning Tests of Tasks 2 to 4

Group	Task 2		Task 3		Task 4	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Experimental (N=26)	85.6	12.8	83.7	16.7	62.4	20.2
Control (N=27)	79.3	21.2	95.9	7.3	67.0	17.6
$t$ -score	1.30		-3.49*		-.89	

\* $p < .002$

As was mentioned previously, each task step was broken down into substeps for scoring purposes, and one subset of these points was for sequential position, which is essentially a measure of correct order. From these data, a sequential score was tabulated to determine whether there was any differential effect by group on this measure. The mean sequential percentage correct for each group on the learning and retention tests of task 1 is shown in Table 3. The mean sequential percentage correct for each group on the learning tests of tasks 2 to 4 is shown in Table 4. These scores consistently parallel the overall scores (Tables 1 and 2), and no unique patterns are apparent. No statistical tests are reported on these data since these scores are correlated with the overall scores.

On the attitude questionnaire, subjects were asked to indicate their agreement/disagreement with 10 statements concerning the training materials by means of a 5-point scale (1 = strongly disagree, 5 = strongly agree). For both groups, an average response was calculated on each of the 10 statements. These averages are shown in Table 5. No differences were statistically significant.

Table 3

Mean Sequential Percentage Correct for Groups  
on the Learning and Retention Tests of Task 1

Group	Test			
	Learning		Retention	
	$\bar{x}$	s	$\bar{x}$	s
Experimental (N=26)	59.0	9.7	47.2	12.5
Control (N=27)	50.2	20.0	47.7	17.8

Table 4

Mean Sequential Percentage Correct for Groups  
on the Learning Tests of Tasks 2 to 4

Group	Task 2		Task 3		Task 4	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Experimental (N=26)	87.9	14.3	77.0	22.9	66.2	24.7
Control (N=27)	81.2	22.5	94.5	8.5	72.4	16.9

Table 5

Median Responses of Groups on the  
Attitude Questionnaire

	<u>Experimental</u>	<u>Control</u>
(1) Overall, the training materials were easy to use.	4.27	4.38
(2) Studying a task was fun, in fact, almost like a game.	3.36	3.56
(3) I learned a lot about the tasks from using the training materials.	4.08	4.00
(4) After I used the materials, I could picture myself doing the task.	4.36	4.09
(5) The training materials made it easy to <u>practice</u> the steps of a task.	4.39	4.25
(6) I would want to use these types of training materials again to study other maintenance tasks.	4.06	3.86
(7) I found it difficult to keep my attention on studying for the entire time.	1.86	1.95
(8) The training materials were boring to use.	2.23	1.92
(9) After using the training materials, I think I could easily locate most of the controls used on the actual test station.	4.50	4.33
(10) Although I have not seen the 6883 Test Station, I feel much more familiar with many of its controls and displays.	4.54	4.36

Key

- 1 - Strongly disagree
- 2 - Disagree somewhat
- 3 - Don't know/neutral
- 4 - Agree somewhat
- 5 - Strongly agree



The experimental group was given additional questionnaire items on topics unique to their training materials. Those results are shown in Table 6. The extra items were intended for descriptive purposes only, and no unusual trends were observed.

Table 6

Responses to Attitude Questionnaire  
Completed by Experimental Group Only

	<u>Response Frequency</u>					<u>Median</u>
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	
(11) The study guide was easy to use.	1	0	0	10	15	4.63
(12) The study guide was a valuable aid in learning the tasks.	1	0	5	9	11	4.28
(13) The practice board was easy to use.	2	1	2	8	13	4.50
(14) The practice board was a valuable aid in learning the tasks.	4	0	1	11	10	4.23
(15) Which part of the training materials was most important in learning the tasks? (Circle one answer)						

	<u>Response Frequency</u>
a) Study guide	4
b) Practice board	1
c) Both about equally	19
d) Neither	1

Key

- 1 - Strongly disagree
- 2 - Disagree somewhat
- 3 - Don't know/neutral
- 4 - Agree somewhat
- 5 - Strongly agree

## DISCUSSION

In general, these evaluation results were mixed with respect to the effectiveness of imagery versus conventional training materials. Three of five recall tests revealed no significant difference between the experimental and control groups; one test resulted in significantly higher performance by the control group; and one test resulted in significantly higher performance by the experimental group. The latter significant difference favoring the experimental group on task 1 is considered to be important since the primary analysis performed in this study was between performance on task 1 and delayed recall testing on task 1. A number of issues are suggested by these results.

### Interference and Facilitation

The interaction found on the learning and retention tests of task 1 is shown in Figure 1. As can be seen, the experimental group demonstrated superior knowledge of the task when tested immediately after the study period. It is reasonable to conclude that some aspect of the imagery training materials was the cause of that superior performance. However, it can also be seen that this advantage had disappeared by the time of a retention test for the task, administered approximately 2 hours later. This result is somewhat unexpected, since the amount of forgetting from initial learning test to delayed recall testing should be the same for both groups. The level of forgetting experienced by the experimental group is not large in view of the potential interference caused by performance on tasks 2 through 4. However, the constant performance level recorded by the control group may indicate that the performance of tasks 2 through 4 by this group was facilitating rather than interfering.

Interference effects are expected to be greatest when there is a high degree of similarity between tasks, and the intervals between tasks are short. Since tasks 1 through 4 were highly similar with respect to the nature of stimuli and responses required, confusions caused by similarity may have produced interference and a decrement in performance. Thus, the activity during the retention period could have affected the experimental group differently than the control group. This activity consisted of studying tasks 2 to 4, which dealt with the same equipment and was, therefore, related to the items in task 1. It is conceivable that

the similarity could have interfered with the experimental group's memory for the task, while it had no effect on the control group. This could occur if the two groups developed qualitatively different memories of the procedure, i.e., spatial versus verbal.

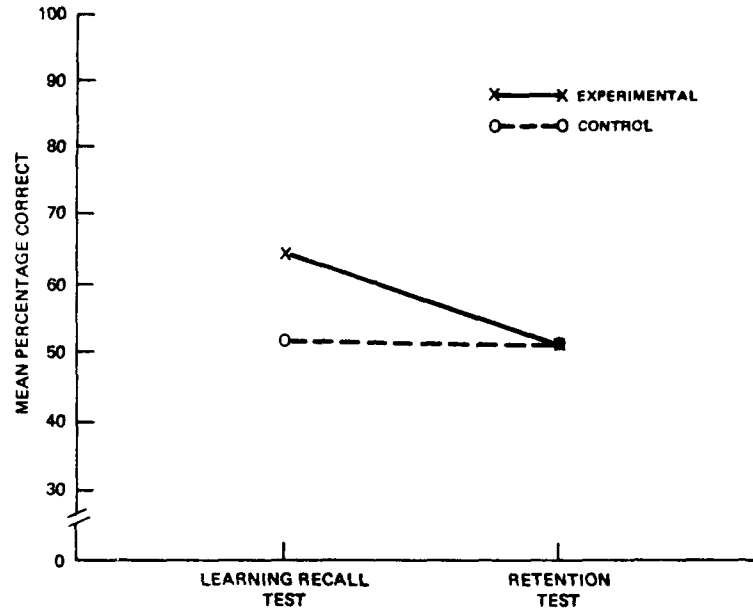


Figure 1. Mean percentage correct for groups on the learning and retention tests of task 1.

Conversely, the intervening activity may have facilitated the memory of the control group members. While the experimental group's knowledge was undergoing an expected information loss, the control group's knowledge may have been "artificially" strengthened by tasks 2 to 4. Figure 1 does indicate that the control group showed almost no decrement over the 2-hour retention period. This was unexpected, since the group had a relatively brief training period, and suggests that the intervening activity did facilitate their final performance.

#### Ceiling Effect

The learning test results for tasks 2 to 4 were inconclusive with respect to the superiority of the imagery training materials. The results for tasks 2 and 4 showed no difference between the two groups. It was not expected, however, that the control group would demonstrate superior

knowledge on task 3. Rather, it was expected that the experimental group would perform at least as well on all tasks. The fact that task 3 showed itself to be a relatively short and easily memorized task may have accounted for the results. The imagery strategy is theoretically most effective when spatial demands are highest, as with task 1.

These results indicate that this particular imagery technique is no more effective than the conventional method for tasks 2 to 4. However, it should be emphasized that these results are generalizable only to procedural tasks with similar characteristics. In fact, while the four tasks used in this experiment may have been representative in kind of those typically performed on the 6883 Test Station, they may not have been difficult enough for the experimental technique to show an advantage over the conventional method. The control group's accuracy over all five recall tests averaged approximately 70%, with a relatively brief study period of 10 to 20 minutes per task. This baseline performance was much higher than expected. Thus, the experimental group's lack of overall superiority could be accounted for by a "ceiling" effect.

#### Equipment Mock-Up

The materials used by the control group have been termed conventional training materials. This is because the procedural steps they used as their basic aid in learning the tasks were excerpted from the technical orders. In addition, they were allowed to use the test station mock-up as a reference to the actual equipment, since they had never seen it before. This mock-up may itself have been a significant training aid. The experimental group was trained on a graphic representation of the test equipment and was required to transition to a photographic mock-up for testing. The control group, however, used the same materials for learning as well as testing. As a result, the experimental procedures may have inadvertently contributed to a practice effect for the control group, which produced almost no loss from learning to delayed recall testing two hours later.

In addition, informal observation during the tests revealed that some control subjects were using the mock-up as a form of "simulator." These subjects were observed making physical movements on the mock-up, as if actually performing the task--e.g., punching in numbers on the

keyboard photograph with their fingers. This may have assisted their practice of the tasks and provided a spatial component to their memory of the tasks. The presence of both features (practice and spatial memory) was thought to be characteristic of the imagery materials alone. If the mock-up served to provide a spatial memory enhancement, then the key advantage for the experimental group may have been neutralized by the mock-up.

This latter suggestion is indirectly supported by the results of the attitude questionnaire (see Table 5). There was very little, if any, difference in how the two groups felt about their particular training materials. In particular, both groups could picture doing the tasks (question #4), felt practice was easy (#5), and were reasonably familiar with the test station after training (#9 and #10). Therefore, both groups may have been provided with an important visual element for learning these procedural tasks.

This reasoning could explain why the control group was superior on task 3. This task was relatively brief and the group's technical order instructions were printed concisely on one page, making their study and practice reasonably straightforward. The mechanics of the imagery technique, on the other hand, may have made this task more cumbersome and complex for the experimental group. They may have spent their time trying to understand how to practice rather than actually practicing the steps. Thus, the conventional materials may be more effective for short, easy tasks, but one would expect the imagery materials to be superior when the tasks are long and complex.

It should be emphasized that this experiment tested only one particular imagery training method in a very limited setting. These results do not necessarily apply to other such methods. In fact, its imagery-producing capability has not yet been definitively shown. The imagery component remains untested, as do the technique's other elements, e.g., facilitation of practice, increased motivation (as by its game-like setting), etc. These questions are left for future inquiry.

## CONCLUSIONS AND RECOMMENDATIONS

The imagery training technique, as used here, had mixed success relative to the control training method. However, it should be noted that the technique was tested on a very limited number of procedural tasks, and there is evidence that these tasks may have been too simple to enable the imagery technique to demonstrate superiority. The results suggest that the imagery training technique may be more appropriate for training more complex procedural tasks and tasks with higher spatial and psychomotor components.

The success of the experimental group on task 1, in light of the equal performance results obtained on the recall test, makes this study inconclusive as to the effectiveness and value of the technique. As an exploratory evaluation, however, these results do suggest the need for refinements to both the technique and the evaluation method. It is recommended that further work manipulate task difficulty in order to determine the technique's relative effectiveness for highly complex situations. Also, the various elements of the imagery technique should be isolated in order to determine what element or combination of elements is sufficient for effective training. It is also recommended that future experiments be designed to control for possible interference effects by controlling materials presented during the intervals between presentation of tasks. Materials low in similarity to the experimental tasks could be used under a variety of experimental arrangements.

Finally, the unexpected success of the conventional training materials has suggested the value of the equipment mock-up for procedural training. Considering the simplicity of that mock-up, further study should investigate the use of such devices as possible training aids.

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APPENDIX A  
Training Materials

Figure A-1  
Sample Imagery Study Guide


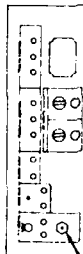

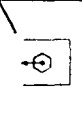


TO INSTRUCTIONS	IMAGERY INSTRUCTIONS	USER'S RESPONSE CONTROL DISPLAY	IMAGERY TRAINING ENVIRONMENT	6803 SECTION
<p>SCU Controller A2A1 115V AC ON INPUT ON RESET error breaker</p>	<p>Locate the SCU Controller panel</p> <p>2 Plug the 115V AC ON INPUT error breaker to ON RESET</p>	<p>Reset</p> 		
<p>Power Input Plug A2A2 POWER switch ON FILTER MODE switch PROGRAM</p>	<p>Locate the Power Input plug panel</p> <p>3 Plug the POWER switch up to ON</p> <p>4 Set the FILTER MODE switch at PROGRAM</p>	<p>Reset</p> 		

Figure A-2(a)  
 Sample Line Drawing from Practice Environment  
 PRELIMINARY CONTROL SETTINGS

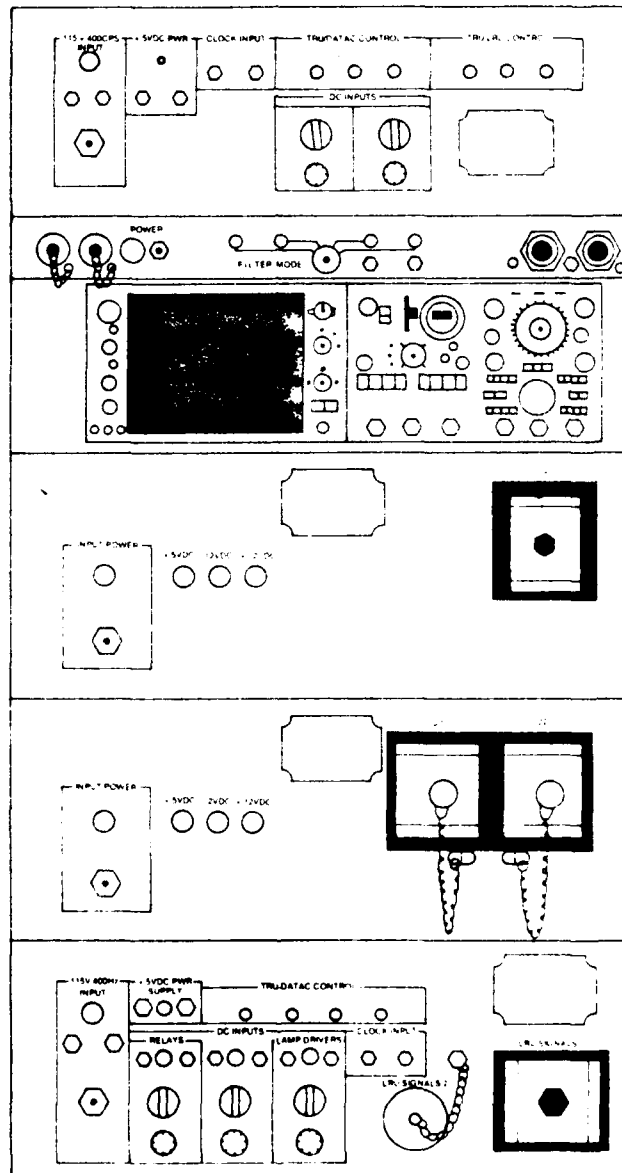




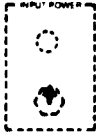



Figure A-2(b)  
Sample Answer Key from Practice Environment

PRELIMINARY CONTROL SETTINGS

**Figure A-3**

**Sample of Conventional Training Materials**

**8) Micrologic Power Supply A1A9**

RACK BLO circuit breaker	ON
CTR TMR FAN circuit breaker	ON
CTR TMR PWR CONT circuit breaker	ON
DATA C FAN circuit breaker	ON
DATA C PWR CONT circuit breaker	ON

**9) SCU Controller A2A1**

115V 400 CPS INPUT circuit breaker	ON/RESET
------------------------------------	----------

**10) Ratio Input Filter A2A2**

POWER switch	ON
FILTER MODE switch	PROGRAM

APPENDIX B  
Experimental Materials

## I. EXPERIMENTAL PROCEDURES

1. Set up training materials at table.
2. Bring subjects in and seat them at tables. Enter names in log.
3. Read introduction:

"In this project, we are studying the design of training materials for Air Force maintenance personnel. In particular, we are evaluating various types of materials in order to improve present training methods. We would like you to use some of these materials in order to determine how well you can learn from them and what your reaction is to them.

"In brief, you will be asked to use a set of training materials to study some maintenance procedures. We will then test you to see how much you can remember of the procedures. At the end of all this, you will be asked to fill out a questionnaire concerning what you did.

"Please note that this is not an IQ test and your performance does not reflect anything about you. But it does tell us something about the training materials. Any questions before we begin?" (Pause)

4. Read instructions:

"To start, we want to see how well you can remember geometric shapes. You will be given a sheet of paper containing 15 different designs. Some designs are regular and simple, and some designs are irregular and complex. You are to study all of these shapes for 5 minutes. You can study them in any order and spend whatever time you'd like on each. You can also study them any way you'd like. Keep in mind that you will be asked to draw as many designs as you can later without having this sheet to look at. Any questions? (Pause)

"Here are the designs. When you get them, you can start studying. I will tell you when to stop."

5. Pass out study sheets.
6. Time 5 minutes.



7. Read instructions:

"Please stop. You can turn the sheets in to me."  
(Collect sheets)

"Now that you have studied these shapes, we would like to see how much you can remember. On the answer form, fill in your name and today's date (give date and pass out forms). Then try to draw as many of the shapes from memory as you can. If possible, draw them in the correct box although this is not critical. Try to draw as many as you can with whatever detail you can remember. If you can only remember part of the design, put that down. Any questions? (Pause)

"Take the next few minutes and draw whatever you can remember."

8. When subjects are finished, collect answer sheets.

9. Read introduction:

"The training materials you will use deal with aircraft maintenance test equipment and, in particular, the 6883 Test Station. This test station is used to perform automatic and manual checkout of converter and flight control LRUs of the F-111 Weapon System at the intermediate level of maintenance. The large photographic mock-up in front of you shows the test station panels.

"In addition to LRU checkout and troubleshooting, technicians must also keep the test station itself in operational condition. The required tasks include performing a self-test of the test station, calibrating equipment, and replacing faulty test station modules. Today, you will be studying a representative sample of these types of tasks."

10a. If subjects are in the imagery group, read the following instructions. If not, go to step 10b.

"At this time, I would like to explain what type of training materials you are going to use today.

"The materials you will use are based on mental imagery techniques. The method it uses to teach procedural tasks is probably different than any you have used before. You learn the procedures for a given task by trying to form a mental image of what you would do at each step in the job. Therefore,

it might teach you to turn a particular switch on, then adjust a certain knob while looking at a meter, etc. You learn the correct steps by practicing them in a certain way. The materials are designed to help you remember what to do by having you form a mental picture of the controls in the correct positions and the displays with the correct readings. When you use the actual equipment, this mental picture might make it that much easier to remember, for example, where a particular control is located and to what position it should be set.

"The way you will practice the correct steps is as follows. You will have a line drawing of the equipment that is to be used. You will make marks on the drawing with a stylus to indicate what should be done for a particular step of the procedure. This is done for every step. When you have finished making the marks you think are correct, you can check your answers to see if they are, in fact, correct.

"Now, there are a couple of other things I should explain to you before I show you the materials. First, when you make the marks on the drawings, you won't see them. You'll be using a stylus which won't have any lead or ink. But your marks will be recorded underneath the drawing on a 'magic slate' type of material. Therefore, after you have tried to make whatever marks you can remember, you will look underneath and check your answers with an answer key. Then, your answers can be erased and you can try again.

"The technique will become clearer to you after I show you the materials you will use and explain what to do. Are there any questions at this time? (Pause)

"Now I'll show you the materials you'll be using.

"The first important part is the study guide. (Show it) This booklet does a couple of things for you. First, it shows you what the correct steps are for a particular task. Second, it shows you what kind of mark you should make for each step.

"Turn to the first page of your study guide and I'll explain it to you. (Pause) This task is called the Preliminary Control Settings. On the far left side are the steps from the tech orders. Next to that is a restatement of these steps to show you exactly what should be done. The next column shows the kind of mark that represents that step and then you can see that mark on top of the appropriate

control. If you follow the arrow you can then see where the control is on the drawing. A photo of the equipment is shown next to that.

"To see this more concretely, let's look at the first couple of steps. The first step (actually it's unnumbered) is to locate the Power Distribution Panel. This step doesn't have a mark since we are only finding out where that panel is. The Control/Display column shows you where to find the panel on the 6883 Test Station. The next step (numbered #1) is to set the SELECTOR Switch at OFF. To practice this, you will be making a line as is shown. You can see it correctly positioned on the control itself. Following the arrow, we can find the SELECTOR Switch on the Power Distribution panel. If you want to see a picture of the switch, it is to the right on that page.

"After we've looked at this step to understand what to do, we would then go to the next step. To repeat, this study guide has two purposes. First, it shows you what the correct steps are for the task. Second, it shows you what kind of mark to make for each step and where to make it on the drawing.

"The next thing I will show you is where to make the marks and how to practice them. But first, are there any questions on the study guide? (Pause)

"The other important part of the training materials is the practice board. (Show board and materials) To start with, it has photographs of the eight sections of the 6883 Test Station. These photographs let you see what the controls and displays look like and where they are located on the actual test station.

"The clamps are used to hold the line drawings you will be making your 'invisible' marks on. To set things up, this is what you do. (Demonstrate and have them do it) First, you select the appropriate line drawing (notice the titles on top of them). Attached to each is a plastic answer key which I'll explain in a minute. Insert the line drawing (with answer key) under the plastic covering of the magic slate, then clamp this down on top of the appropriate photo. The line drawing should be similar to the picture you cover up. (Check students)

"Now you are ready to practice the task. Notice what happens when you make a mark on the drawing (do it). You don't see your mark, but if you look under the drawing, it can be seen on the magic slate. If the mark you make was the correct one, it would correspond to the mark etched out on the colored answer key. This lets you know if you were correct and, if not, what mark you should have made. To erase your marks, you lift up on the thin plastic sheet.

"Let's take a minute to practice what to do. (Practice making marks and answer questions)

"Finally, let me explain how to use the study guide along with the practice board. First, before beginning, you will be told what the task is to be studied and what boards to set up. Then, when you are ready, you find the task in the study guide and follow what it says from the first step. Initially, you should go step by step through the study guide and try to learn what kind of marks correspond to each step. You aren't expected to memorize all of the steps at this point. Just become familiar with them. As you read the steps in the study guide, you can follow along with the practice board. In fact, you can even make the marks as you move from step to step.

"After you think you have learned some of the steps, try practicing on the board without looking at the study guide. Remember, the correct answers can be found underneath the drawing. After you have made as many marks as you can remember, check your answers and see what the correct ones are. Then erase and try again. If you get confused by the steps or need more information, go back to the study guide to see the steps again. But it is important that you start practicing as soon as you feel able. Study at your own pace and don't worry about anyone else. Everyone will probably use these materials a little bit differently.

"Here is a list of steps on how to use the materials in case you get confused. Of course, if necessary you can ask me for help. Any questions? (Pass out sheet)

"Does everyone think they know how to use the materials?"

10b. If subjects are in control group, read the following instructions. If not, go on to step 11.

"At this time, I would like to explain what type of training materials you are going to use today. (Pass out materials)

"These materials are similar to the tech orders for doing these tasks. We have taken from the tech orders those statements which apply to the given task and reprinted them in the booklet titled Study Guide for Representative Tasks. If you turn to page 1 you will see the type of statements you will be asked to remember. (Pause)

"There are two other things to supplement this study guide. First, in front of you is a large photographic mock-up of the 6883 Test Station. You can use this large picture to see what the actual equipment looks like and to locate the controls you will be dealing with.

"Since it is difficult to read all of the lettering on these photos, a second supplement is provided (show it). This contains copied pages from the tech orders of the panels and controls you will be studying. They are laid out in the order presented in the tech orders. Note that the first page has an overall picture of the test station to help you identify where panels are, etc. In essence, you have all the information you would have if you were studying these tasks from the tech orders.

"Let me suggest how you might use these materials to study a task. To start, you should review the T.O. steps provided in the study guide. At this point your goals should be to familiarize yourself with the steps and clarify what is accomplished. Next, use the large photographic mock-up of the test station to see what controls or displays are being used in the task. The supplementary booklet may also help locate particular panels and controls. At this point, you should read through the steps for the task repeatedly, trying to remember as much as you can. Use the pictures as an aid to remembering what to do. Try to remember as much as you can, but don't worry if you can't remember everything.

"Are there any questions on how to use these materials to study a task?" (Pause)

11. Read instructions (both groups).

"Now that we are ready to begin, let me explain what we are going to do. You will be asked to study four different tasks one at a time. Each task will be described to you and then you will be given some time to study its steps with the training materials I have already described. You will be told before you start how much time you will be given.

"Use this time to learn as many of the task's steps as you can. After this time is up, you will be asked to write down as many steps as you are able. So try to remember as much as you can. However, don't worry if you can't remember everything. Time may be too short to do that.

"Don't go on to the other tasks before you are told to. Spend your time on the task you are told to work on.

"Any questions?" (Pause)

12a. Read task 1 instructions (both groups).

"The first task is called the Preliminary Control Settings. This is part of what should be done before the test station is actually turned on. The individual pieces of equipment are readied before the application of power. You will be studying a part of these initial settings."

12b. Read instructions (imagery group only).

"To ready the practice board, take the three drawings that are titled Preliminary Control Settings at the top and set them up in the appropriate positions." (Check all boards)

12c. Read instructions (both groups).

"Any questions? (Pause)

"Now turn to the correct part of the study guide and begin. Study the steps as you were previously instructed. You will have 20 minutes."

13. Time 20 minutes. Answer individual questions as necessary.

14. Read instructions for learning test (after 20 minutes).

"Please stop and put all training materials aside except for the large photographic mock-up. (Check that materials are away)

"Now that you have studied this procedure, we would like to see how much of it you have learned. We want you to write down as many steps of the procedure as you can remember with as much detail as possible. You will use these answer sheets. (Pass out answer forms)

"Fill in your name, today's date and task number (#1). As you can see, the answer form has lines numbered 1 through 50. These numbers do not correspond to the number of steps in the task. They are only there to help you in listing the steps you remember.

"We want you to take a few minutes and write down the steps you can remember. Imagine yourself doing the task and write down just what you would do. For example, if the first step is to turn a piece of equipment on, you should write down exactly what you would do, such as 'Push the power button in on the control panel.' If you don't know the name of the control, describe its location with the aid of the large photograph you have in front of you. Example: 'Push the left-most button on the top, left panel.' You may even be able to get the name of the control from the photograph.

"If you can't remember all of the details, put down what you can remember. Example: 'At this time, the meter should read some value that I can't remember.' Also, if you do some steps over and over, list them each one at a time. If numbers are involved (such as meter readings), put down those you can remember. In general, we want you to put down every and any detail you can remember.

"Take your time and try to be exact. Any questions?  
(Pause)

"You may start. Don't forget your name, today's date and task number."

15. After students are finished, collect answer sheets.

16a. Read instructions (both groups).

"We will now go on to task 2. This task is called the Turn-on Procedure. In particular, it covers the checking of various indicator lamps after power has been applied to the test station. This is to assure that all circuits appear to be operating normally."

16b. Read instructions (imagery group only).

"To ready the board, take the three drawings that are titled Turn-on Procedure at the top and set them up in the appropriate positions." (Check boards)

16c. Read instructions (both groups).

"Any questions? (Pause)

"Now turn to the correct part of the study guide and begin. Study the steps as you were previously instructed. You will have 20 minutes."

17. Time 20 minutes. Answer individual questions as necessary.

18. Read instructions for learning test (after 20 minutes).

"Please stop and put all training materials aside except for the large photographic mock-up. (Check that all materials are away)

"Again, we would like to see how much of this task you can remember. Write down as much detail as possible. If you can only remember part of a step, write down that part. Be careful and exact. Again, fill in your name, date, and task number. (Pass out answer forms)

"Any questions? You may begin."

19. After students are finished, collect answer sheets.

20a. Read instructions (both groups).

"We will now go on to task 3. This task is called the Adjustment of Power Supply A2A9PS4. The procedure you will be studying involves the initial steps when adjusting this power supply. In particular, the DVM is set up to measure the output of power supply PS4."



20b. Read instructions (imagery group only).

"To ready the board, take the one drawing that is titled Adjustment of Power Supply at the top and set it up in the appropriate position." (Check board)

20c. Read instructions (both groups).

"Any questions? (Pause)

"Now turn to the correct part of the study guide and begin. Study the steps as you were previously instructed. You will have 10 minutes."

21. Time 10 minutes. Answer individual questions as necessary.

22. Read instructions for learning test (after 10 minutes).

"Please stop and put all training materials aside except for the large photographic mock-up. (Check that all materials are away)

"Again, we would like to see how much of this task you can remember. Write down as much detail as possible. If you can only remember part of a step, write down that part. Be careful and exact. Again, fill in your name, date, and task number. (Pass out answer forms)

"Any questions? You may begin."

23. After students are finished, collect answer sheets.

24a. Read instructions (both groups).

"We will now go on to task 4. This task is called the Calibration of AC Voltmeter. It involves the setup and calibration of the ac voltmeter on the Variable Power Control Panel. As you will see, the procedure includes a series of voltage ranges which must be checked. Although it appears difficult, try to remember as many of these as you can along with the other steps of the procedure."

24b. Read instructions (imagery group only).

"To ready the board, take the one drawing that is titled Calibration of AC Voltmeter at the top and set it up in the appropriate position." (Check board)

24c. Read instructions (both groups)

"Any questions? (Pause)

"Now turn to the correct part of the study guide and begin. Study the steps as you were previously instructed. You will have 15 minutes."

25. Time 15 minutes. Answer individual questions as necessary.

26. Read instructions for learning test (after 15 minutes).

"Please stop and put all training materials aside except for the large photographic mock-up. (Check that all materials are away)

"Again, we would like to see how much of this task you can remember. Write down as much detail as possible. If you can only remember part of a step, write down that part. Be careful and exact. Again, fill in your name, date, and task number. (Pass out answer forms)

"Any questions? You may begin."

27. After students are finished, collect answer sheets.

28. Read instructions:

"Now that you have studied all 4 tasks, we would like to see what you can remember about the first task. That was the one called Preliminary Control Settings. We would like you to put down the steps you can remember. If you can put down more steps than before, do so. If you don't remember as much, write down what you do remember. Again, be careful and take your time. Don't forget your name, date, and task number. Call this task 5.

"Any questions? (Pause) You may begin."

29. After students are finished, collect answer sheets.

30. Read instructions:

"You have participated in an experiment to test different types of training materials. Your group's performance will be compared with another group's performance to determine which training materials are most effective for students.

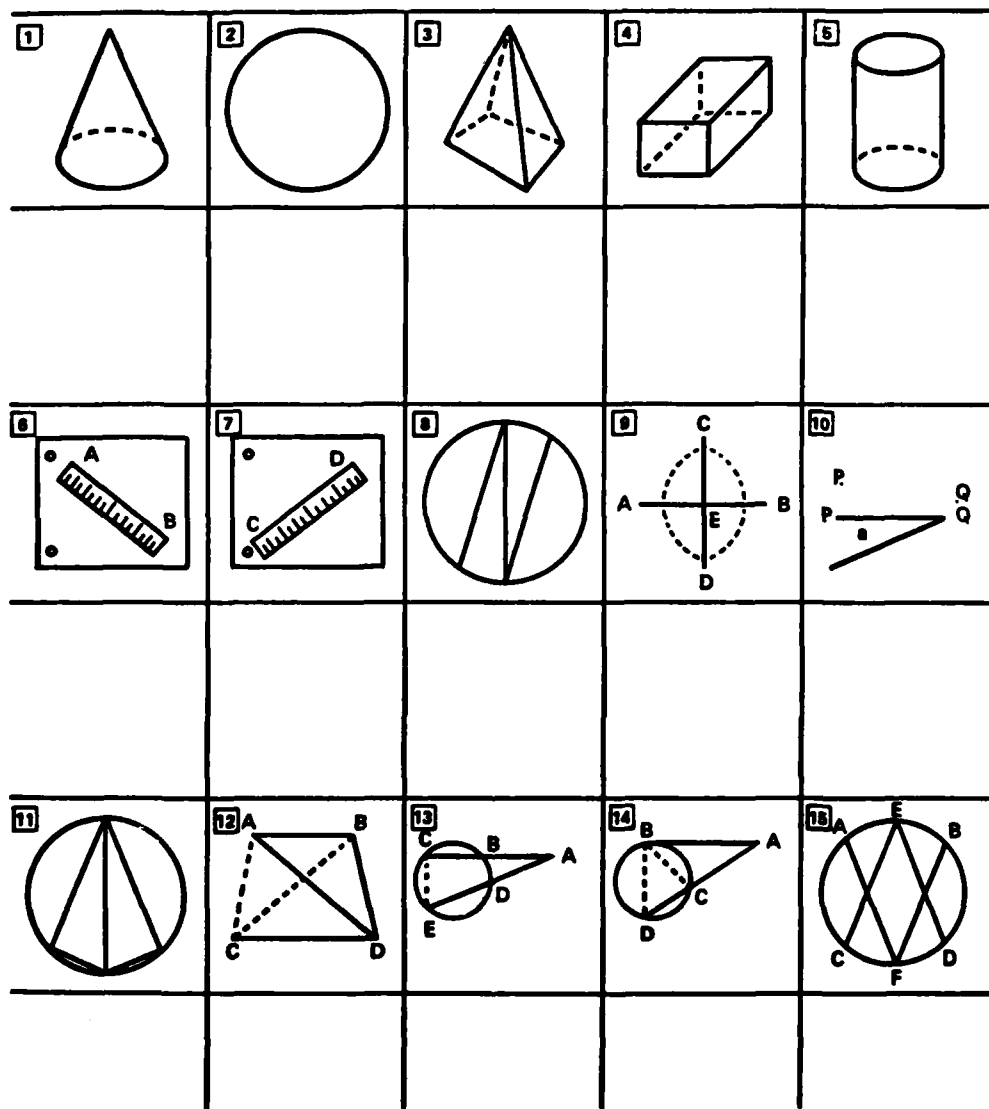
"As one last task, we would like you to fill out a questionnaire. This asks you about your reaction to the training materials. Please read the instructions carefully and answer each question based on how you really feel.

"Thank you for participating today. Please don't talk to other students about the details of today's experiment since they may be participating in it later."

31. Pass out questionnaire. Collect when finished.

## II. IMAGERY PRETEST

Directions: Study the figures below as directed. You will be asked to reproduce them.



### III. QUESTIONNAIRE

#### Part 1

Name \_\_\_\_\_ Date \_\_\_\_\_

Instructions: Mark each question to indicate how much you agree or do not agree with the statement. Circle the number to the right of each question to show how much you agree or disagree as follows:

- 1 - Strongly disagree
- 2 - Disagree somewhat
- 3 - Don't know/neutral
- 4 - Agree somewhat
- 5 - Strongly agree

Example:

Disagree-----Agree

- |     |   |   |   |   |   |   |
|-----|---|---|---|---|---|---|
| (0) | I believe summer is usually warmer than winter.   | 1 | 2 | 3 | 4 | 5 |
| (1) | Overall, the training materials were easy to use.   | 1 | 2 | 3 | 4 | 5 |
| (2) | Studying a task was fun, in fact, almost like a game.   | 1 | 2 | 3 | 4 | 5 |
| (3) | I learned a lot about the tasks from using the training materials.                            | 1 | 2 | 3 | 4 | 5 |
| (4) | After I used the materials, I could picture myself doing the task.                            | 1 | 2 | 3 | 4 | 5 |
| (5) | The training materials made it easy to <u>practice</u> the steps of a task.                   | 1 | 2 | 3 | 4 | 5 |
| (6) | I would want to use these types of training materials again to study other maintenance tasks. | 1 | 2 | 3 | 4 | 5 |

	Disagree-----Agree				
(7) I found it difficult to keep my attention on studying for the entire time.	1	2	3	4	5
(8) The training materials were boring to use.	1	2	3	4	5
(9) After using the training materials, I think I could easily locate most of the controls used on the actual test station.	1	2	3	4	5
(10) Although I have not seen the 6883 Test Station, I feel much more familiar with many of its controls and displays.	1	2	3	4	5

Part 2

Disagree-----Agree

- |   |   |   |   |   |   |
|---|---|---|---|---|---|
| (11) The study guide was easy to use.                             | 1 | 2 | 3 | 4 | 5 |
| (12) The study guide was a valuable aid in learning the tasks.    | 1 | 2 | 3 | 4 | 5 |
| (13) The practice board was easy to use.                          | 1 | 2 | 3 | 4 | 5 |
| (14) The practice board was a valuable aid in learning the tasks. | 1 | 2 | 3 | 4 | 5 |

- 
- (15) Which part of the training materials was most important in learning the tasks? (Circle one answer)

- a) Study guide
- b) Practice board
- c) Both about equally
- d) Neither

- (16) The one thing I found most interesting about the training materials was \_\_\_\_\_.

- (17) The one thing that helped me the most to learn the task was \_\_\_\_\_.

Table B-1

Summary Table of the Analysis of Variance  
on the Learning and Retention Test Scores of Task 1

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Between				
A (Imagery)	1109.68	1	1109.68	2.19
Subjects Within Groups	25837.58	51	506.62	
Within				
B (Delayed Recall)	1398.34	1	1398.34	22.78*
A x B Interaction	896.80	1	896.80	14.61*
Subjects Within Groups x B	<u>3131.36</u>	<u>51</u>		
Total	32373.76	105		

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\* $p < .01$